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18 September 1979

East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 6/79)

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INTERNATIONAL AFFAIRS

EIGHTH INTERNATIONAL SYMPOSIUM ON PHOTON DETECTORS

Prague SLABOPROUDY OBZOR in Czech No 5, 1979 pp 246-249

[Report on symposium by Eng Miroslav Jedlicka, candidatus scientiae: "The Eighth International Symposium on Photon Detectors"]

[Text] The Eighth International Symposium of IMEKO [International Measurement Confederation] entitled "Photon Detectors" was held in Prague 22-25 August 1978. The Prague Technical House, in cooperation with the subcommittee on photon detectors of the Czechoslovak National Committee of IMEKO organized the activities held at the Central House of Culture of Railroaders in Prague at the Vinohrady. A total of 98 specialists from 14 countries participated in the symposium: 1 from Bulgaria, 5 from France, 6 from Poland, 7 from Hungary, 2 from Belgium, 1 from the FRG, 1 from West Berlin, 11 from the USSR, 9 from the GDR, 1 from Canada, 2 from Great Britain, 1 from the United States, 1 from the Republic of South Africa, and 50 from the CSSR.

The Eighth Symposium on Photon Detectors was a continuation of the preceding activities of the same name organized by IMEKO TC-2 [International Measurement Conference Technical Committee Number 2] between 1963 and 1976. Its most important function was to allow the participants to exchange information about new scientific and technological results, primarily in the area of the generation of an electric signal in response to the interaction of electromagnetic radiation in the optical part of the spectrum with a material medium, as well as to sponsor an exchange of information between manufacturers and users of detectors. Special emphasis was placed on detectors for measuring purposes in photometry and radiometry, but radiation receptors for power purposes were not neglected. In all, 56 papers were given, 15 of them by Czechs.

After the symposium was opened by a representative of the Czechoslovak organizational committee, the proceedings began with three introductory presentations. The first speaker was the chairman of IMEKO TC-2, Prof P. Gorlich (GDR), who discussed the most recent research in the field of photon detectors and their applications. In a detailed review of the subject based on well researched study, he discussed vacuum and gas-filled photon detectors, the photoelectric effect in semiconductors, optical-electronic devices, nonselective detectors, television camera tubes, the exploitation of new phenomena for photon detection and modern applications of these detectors.

The second of the introductory papers dealt with image detection at very low light levels. Its author was C. I. Coleman of England. He began with the basic criteria determined by the signal-to-noise ratio and the quantum efficiency, allowing for the practical limits set by the noise of the detector itself and its final accumulation capacity. Coleman outlined the most important principles of optical image-dector design, and concluded with a discussion of the properties of detectors based on counting photoelectrons resulting from the absorption of photons bearing information about the image.

In the third of the introductory papers, J. Geist of the United States dealt with applications of quantum radiometry. He first briefly discussed the first 40 years of practical radiometry, from the time of Angstrom's invention of the compensated pyrheliometer, which years were devoted to the application of the Stefan-Boltzman law, years when attempts were made to minimize the difference between radiometers based on black-body radiation and those based on quantum detectors. Interest in quantum radiometry increased after 1960 in connection with the space exploration programs and the invention and manufacture of lasers. Today, even small laboratories are able to use commercial radiometers and compare their results with the official radiometers of the competent institutions. It is precisely as a result of achieving this second stage of radiometry that work is being done in laboratories all over the world on achieving absolute accuracy better than 0.1 percent.

After these three extensive introductory papers, the symposium proceedings continued with 15-minute presentations devoted to various fields of interest.

M. Morvic, J. Novak, and P. Kordos of the CSSR reported on the photoelectric properties of GaAs-GaAlAs photodiodes prepared by liquid epitaxy. The degree of sensitivity in the visible and near infrared regions of the spectrum is determined by the quantity of aluminum in the ternary compound $Ga_{1-x}Al_xAs$. The results obtained are in good agreement with the functional model.

The work of Z. Cimpel, Mir. Jedlicka, F. Kosek and F. Schauer of the CSSR dealt with the properties of the hetergeneous structure of CdSe-amorphous chalcogenide. The CdSe layer was prepared by sputtering, the chalcogenide layer was evaporated in a vacuum. Its transport and optical properties were studied with respect to a number of technical conditions.

The presentation by Mir. Jedlicka, P. Kulhanek, J. Mravinec and D. Lezal of the CSSR on using this structure as a target for television camera tubes tied in with the preceding one. Their presentation discussed some characteristics resulting from the roughness of the sputtered layer of CdSe and the change in composition of the chalcogenide material $As_2Se_{3-x}S_x$ for values of x between zero and one.

A. Abraham, S. Koc and J. Filko of the CSSR presented a report on the interesting photoelectric properties of amorphous germanium sulphide. The spectral sensitivity of this material is in the range of 500 nm to 1,370 nm; its dark resistivity is 10^{11} to 10^{12} ohm cms. GeS is prepared by deposition from the gas phase on a glass substrate at a temperature of 230° C to 270° C in an evacuated furnace with a thermal gradient.

R. Behrendt, K. H. Herrmann and R. Wendlant (GDR) spoke on the principles [to be considered in] designing various types of infrared-sensitive photoelectric diodes made from a $Pb_{1-x}Sn_xTe$ semiconducter, where x=0.17 to 0.2, it being possible to form homogeneous junctions (N^+P by doping with antimony or NP^+ by doping with cadmium) or a heterojunction, PbTe-PbSnTe. The values of sensitivity achieved are of the order of 10^{10} $cmHz^{1/2}W^{-1}$.

E. Igras, Z. Nowak, J. and T. Piotrowski, workers at the Polish Military Technical Academy, reported the results of their work on (Cd,Hg) Te detectors produced by the isothermal deposition of HgTe on a layer of CdTe evaporated on a mica substrate. The selective detectors are sensitive in the spectral range 800nm to 14 micrometers. Their maximum sensitivity ordinarily exceeds $10^9 cmHz^{1/2}W^{-1}$.

Employing the photoelectromagnetic effect in the (Cd,Hg) Te detector was studied by D. Genzow (GDR) and M. Grudzien and J. Piotrowski (Poland). They determined that in an uncooled detector for wavelengths greater than 8 micrometers, the absorption coefficient is less than the reciprocal of the diffusion length.

L. Kratena and Z. Jarchovsky, workers of the Institute of Radiotechnology and Electronics of the Czechoslovak Academy of Sciences, measured and analyzed photoelectric currents arising in a semiconducter-electrolyte system. They also used their results to study the optical properties of nitrogen and other dopants implanted in GaP.

L. Armand, J. L. Bouillot and L. Gaudort (France) investigated the physical properties of photoelectric emissions from thin layers of calcium. The measurement and study of the layers was carried out in a high-vacuum apppa-ratus at a pressure of 10^{-9} Pa. They found two characteristic thicknesses for which the quantum gain exhibited a maximum value.

N. V. Agrinskaya and G. A. Matveyev (USSR) reported on highly photoelectrically-sensitive crystals of CdTe: Cl, which they determined to have the _n_-type current/voltage characteristic. The negative differential conductivity here clearly arose through nonlinear recombination; the electron concentration is a function of the electric field.

F. Hengstberger (Republic of South Africa) led off a group of presentations on photometry and radiometry with his discussion of the contempory status of quantum radiometry. The modern trend is to use pyroelectric elements for these purposes in addition to improve bolometric and thermoelectric receivers. The author also dealt with the results obtained in extending the theory of instrumental corrective factors and of environmental corrective factors.

J. Zatkovic of the Czechoslovak Meteorological Institute discussed the theory and construction of a symetrical radiometer for optical range emissions. His system makes it possible to measure the correct value of the emission current even when the thermal properties of the materials used for the radiometer are unknown.

C. Frohlich (Switzerland) reported on the important role played by quantum radiometers in the international network of meteorological stations. They are used for solving problems in atmospheric physics and to measure solar radiation up to 1,500 W per sq m and the precise spectral emission of the sun.

A group of Hungarian researchers, O. Dezsi, L. Szonyi, G. Czibula and J. Schanda, discussed the determination of photodetector characteristics for illumination meters. Measurements made on a number of commercial lightmeters showed how the accuracy of the device is affected by spectral characteristics, anistropic sensitivity, linearity, fatigue, etc. Measuring these parameters makes it possible to establish a "quality index" for individual devices.

J. Krochmann (West Berlin) dealt with the problem of establishing suitable corrective functions for modifying the spectral characteristics of measuring detectors used for measuring photobiological effects. Among 19 such effects, the author includes not only vision, color vision and photosynthesis, but also such phenomena as basalioma (cancer of the skin), vitamin D synthesis, etc. For the specific measurement of magnitudes of radiation that are important in studying these phenomena, corrective factors for several commercial devices, most of Western manufacture, were calculated.

In another contribution by F. Hernstberger in the area of quantum radiometry, he summarized the results of recent theoretical investigations into the problems of correcting errors originating in the device and in the environment and directed the audience's attention to other possible subjects in this line requiring theoretical and experimental solution.

T. Peceny and M. Kasik of the TESLA-VUVET [Vacuum Electrotechnology Research Institute] suggested a method of correction in calibrating a secondary radiometric detector based on its experimental comparison with a primary detector using common laboratory equipment.

The measurement of the linearity of photodetectors was the subject of a paper authored by G. Dezsi and L. Fillinger (Hungary). They described using the Saunder method with a specially designed photometer to measure the linearity of different types of photoelectric multipliers with respect to the applied voltage for different spectral compositions of incident radiation, as well as a set-up used to measure the shorted current of Se and Si photocells.

The ever-important problem of linearity was also the subject of a presentation by W. Buddy (Canada), who verified the assertion of the extreme multidecade linearity of silicon photoelectric diodes which, without having been experimentally confirmed, is assumed in the literature. The experiment was based on Sanders test, which uses the double aperture method. The measurements covered approximately nine decades from 10mA to 10pA in Si photodiodes produced by different manufacturers.

G. Andor and L. Fillenger (Hungary) presented a report on using light-emitting diodes as standard light sources for photoelectric multipliers. When a photoelectric multiplier is used as a sensitive measuring detector (at very low light levels) its stability must be regulated. The investigators devised a special feeding source for the light-emitting diode that insured the steadiness of the illumination current, a condition for using light-emitting diodes for these purposes. The advantage of light-emitting diodes consists in their relatively narrow spectral band of radiation, low power consumption, rapid response and the insignificant effect aging has on them.

A survey of applications of the Ettinghausen-Nernst effect to the design of thermal detectors was presented by T. Elbel and E. A. Soaz of the GDR. They pointed out, among other things, that by decreasing the thickness of the sensitive layer it is possible to lower the time constant without at the same time limiting the sensitivity, as is typical for other types of thermal detectors. Specific experiments were carried out on monocrystals of bismuth and on low-melting-point alloys of lnSb-NiSb, including in the form of thin vacuum-deposited layers.

Lead sulphide is one of the materials in which the photoelectric effect has already been studied for a very long time. J. Doubek and S. Synek (CSSR) reported on results obtained in studying a method of limiting hysteresis in layers of PbS prepared by chemical deposition.

H. Murray and A. Piel of France investigated the physical aspects of the photovoltaic effect in MIM structures, specifically, in Al-CdSe-Au. These structures are interesting not only from the standpoint of photometry but also for conserving solar radiation energy.

I. Wegrzecks (Poland) described the results she obtained in work on avalanche silicon photoelectric diodes having active surfaces of 0.2mm diameter. She achieved a gain of greater than 200, a dark current of less than 1 nA and a capacity of less than 5 pF. These diodes are intended primarily for the region of the spectrum between 0.4 to 0.8 um.

V. Jares of TESLA-VUVET discussed the possibility of improving the electron-beam system of Vidicon television camera tubes. The scanning beam affects such tube characteristics as the ability to transmit detail and persistence.

J. A. Astrov and a collective of other Soviet workers presented interesting information about a discharge semiconductor display device based on controlling the bandwidth of the discharge current with a photoconductive electrode.

By using various semiconductors having thick layers of dopants, especially GaAs(Cr), Si(Au), Si(Zn) and GaAs(Cu), they fabricated an image electro-optical meter having a dynamic range of 10^3, a persistence of 10^{-7} and a broad spectral characteristic in the area of 800 nm to 10.6 micrometers.

L. and J. Novak of the Physics Institute of the Czechoslovak Academy of Sciences reported on a pyroelectric detector for Fourier spectrometry in the far infrared region of the spectrum. Triglysine sulfate doped with alanine was used for the detector. They attained results indicating it would be possible to use this type of detector wherever the Golay pneumatic cell has been used in the past.

R. Guttich (GDR) compared the most important photon and thermal detectors in laser technology. The comparison showed that from the standpoint of cost effectiveness, the use of thermal detectors in laser technology is the best compromise. In classifying thermal detectors the author emphasized response and presented examples of measuring lasers with pyroelectric detectors.

K. Berndt (GDR) spoke on a system having a photon detector used for mode stabilization of a continuous laser in spectroscopy with time differentiation and emphasized the importance of mode locking for obtaining continuous series of light impulses with life-times of 1 ns and 0.5 ps.

A group of Polish researchers represented by W. Galus contributed a set of four related papers on the following subjects:

--measuring the factors determining the possibility of achieving the optional characteristics of the uncooled semiconductor detectors (Cd,Hg) Te functioning at a wavelength of 10.6 micrometers;

--optimizing the properties of uncooled photoconductive detectors (Cd,Hg) Te for the region of the spectrum 8 to 12 micrometers;

--the optimal magnitude of x for crystals having the formula $Cd_xHg_{1-x}Te$ for fabricating uncooled photoconductive detectors;

--the analysis of thermal operating conditions of (Cd,Hg) Te detectors.

An analysis of the stability of CdS and CdSe photoconductive detectors was the topic treated by I. Arato and I. Molnar of Hungary. They compared these detectors for the most important technical variables--spectral sensitivity, thermal factors, frequency characteristics and fatigue--and described experiments designed to improve the unsatisfactory stability of the highly sensitive CdS and CdSe elements. Their results showed that achieving the optional placement of recombination and trapping centers in the forbidden band is decisive for the time constant and the thermal coefficient of the elements, and that the time needed to achieve the equilibrium state of the photoelectric current can be substantially shortened.

Improving photovoltaic effects in MIM photon detectors by aging was the subject of the report authored by M. Arslane and A. J. Tosser of France. They proposed a method of aging based on programmed temperature and electric-field increases resulting in improved photovoltaic properties for M-Zn-M photon detectors. An especially great increase in efficiency in the visible light region of the spectrum for temperatures ranging from 77 to 530 degrees K was achieved. Microminiaturized photodetectors of this kind are suited to biomedical techniques.

The Polish researcher M. Brzeska spoke on the problems involved in fabricating PIN photodiodes for the near-infrared region that exihibit a high degree of sensitivity and fast reactions. She presented the results of electric and photoelectric measurements made on a set of photodiodes.

Another Polish researcher, M. Wegrzecki, analyzed the effect of the construction parameters of silicon planar photodiodes on their dynamics, response period, and limiting frequency. He presented experimental data on the BPYP41 photodiode designed for telecommunication systems that supported his analysis.

J. Tousek and P. Bartosova of the Mathematics and Physics Faculty of Charles University spoke on some electrical and photoelectric properties of thin-layer CdTe photon tubes. CdTe is being considered as a material for inexpensive and efficient solar batteries. The thin layer of CdTe is deposited on a corrundum substrate; the rectifying contact is made of gold.

I. Beranek and Michael Jedlicka (TESLA-VUVET) delivered a report on channel electron multipliers. Their presentation summarized the principle and most important characteristics of channel electron multipliers, described the most important operating conditions, surveyed the detection efficiency for different kinds of radiation, the effect of ions on detection efficiency and listed the major applications of single-channel electron multipliers.

The transmission and noise properties of InSb infrared detectors were the subject of the presentation made by J. Sikula and P. Vasina of the physics department of the Brno tekhnikum. They spoke on their investigation of the electrical conductivity, the Hall constant and magnetoresistance in the temperature range 150 to 300 degrees K in samples of InSb manufactured by the national TESLA enterprise. They evaluated the determined values of magnitude of the drift mobility of the charge carriers and the measurements of the spectral bandwidth of the noise current.

Another report on the problems of semiconductor detector noise was presented by N. B. Lukyanchikova (USSR) and contained the results of the theoretical and experimental investigation of a fluctuating photoelectric current in photoelectric resistors and photodiodes: A theoretical analysis of the spectrum of generation recombination fluctuations of photoelectric conductivity in a model incorporating the properties of a real semiconductor, and the results of experiments on fused layers of CdS, and analysis of the noise current in PN photodiodes, and an analysis of the problems of photodetector sensitivity and establishing the parameters determining their magnitude.

R. Behrendt and Ch. Kreuziger (GDR) also investigated noise ratios, specifically, in avalanche silicon photoelectric diodes having a special structure.

A report on the photoelectric properties of a thin-layer heterogeneous structure, metal--CdS--SnO_2, was given by M. Malachowski and colleagues (Poland). They described the technology for fabricating this layered structure and the photovoltaic effect produced by different light conditions.

Other Polish researchers, E. Igras and A. Rodalski, described the properties of detectors having the composition $Pb_{1-x}Sn_xTe$, which they fabricated by evaporation in a chamber with heated walls. The detector is formed by the heterojunction PbTe--$Pb_{0.82}Sn_{0.18}Te$. They also dealt with such problems as fabricating photovoltaic counters for a "window" in the atmosphere in the 8 to 14 micrometer band.

Z. Cuchy's (Monokrystaly Turnov) presentation dealt with pyroelectric detectors for infrared radiation and growing pyroelectric monocrystals of $Pb_5Ge_3O_{11}$. The author explained the principle of the pyroelectric effect and defined the pyroelectric coefficient of voltage response together with noise and limiting sensitivity. He presented a summary of the parameters of some pyroelectric materials and described a method of growing certain pyroelectric crystals.

V. V. Spektor and L. G. Pachomov (USSR) described the mechanism of X-ray photoelectric conductivity of organic complexes with charge transmission that are found in the form of multilayer compounds in the polycrystalline state. Their interpretation is based on the mode orthogonal oscillators and on the projected potential barriers. The course of the electron energy spectra and the description of the nature of conductivity are a result.

Another Soviet researcher, T. M. Burbayev, reported on measuring the dependence of the lifetime of majority and minority carriers on the concentration of dopant in the photoelectric resistor Ge:Zn at the temperature of liquid nitrogen. A CO_2 laser was used as a source of excitation, the radiation was modulated by a high-frequency germanium modulator. The damping characteristic of the photoelectric effect in the 2000 MHz band and the phase lag caused by photoelectric resistance at a frequency of 500 MHz were measured. An optical lag link was used to measure phase shift.

A presentation by a group of researchers from TESLA-VUVET (I. Benc, V. Husa, J. Krig, and J. Urbanec) discussed the results of measuring the spectral sensitivity of four-segment silicon photodiodes developed at TESLA-VUVET for a measuring device with a He-Ne laser. The measurements for blocked and diode modes of operation were compared with the theoretical predictions and on this basis the lifetime of minority carriers was established.

N. M. Kolchanovova (USSR) discussed systems for detecting radiation based on the origin of hot electrons when acted on by light. In such a case, response is not determined by the lifetime of electrons and holes, but is a function of the relaxation of excess photoelection energy. Under certain conditions, this relaxation time must be shorter than the lifetime of majority and minority carriers. The effect can be used to record rapid processes. Specifically, she discussed the experimental results of the photomagnetic effect and of photoelectric conductivity of $A^{III}B^{V}$ crystals under these conditions.

R. Andreychin (Bulgaria) presented an extensive report on the effect of various photon detector environments on their properties and on the possibilities of exploiting suitable properties of these environments.

A summary of photoelectric detectors used for optical pyrometry was presented by D. J. Svet (USSR). He also dealt with the possibilities of determining their parameters in measuring thermal radiation.

All of the papers presented at the symposium will come out in a collection to be published by the international secretariat of IMEKO in Budapest at the beginning of 1979.

The range of topics at this symposium and their level indicated the overall advance made by this sector in recent years, as can be seen by comparing the results of the two Prague symposiums on photon detectors held in 1969 and 1978. In summary, the topics of the 1978 symposium can be divided into the following groups:

--the problems in the fields of research manufacturing processes and the properties of photon detectors of the types optical signal/electrical signal, optical image/electric signal and optical image/optical image with spectral transformation;

--problems of the precision of photon detectors in photometry and radiometry; and

--problems connected with photoelectric power.

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CZECHOSLOVAKIA

AUTOMATIC PRODUCTION SYSTEM IN SKODA MACHINE-TOOL PLANT

Prague STROJIRENSKA VYROBA in Czech No 6, Jun 79 pp 416-420

[Article by Engr Vaclav Blecha and Engr Jan Matejka, Skoda Departmental Enterprise, Plzen: "Automatic Production System in the Machine-Tool Plant"]

[Text] In accordance with Resolution of the Federal Government's Presidium No 21, of 30 January 1975, a production base for nuclear power-plant equipment has been built at the Skoda Departmental Enterprise, Plzen. A part of this production base is also the VS-43 production system installed at the Skoda Machine-Tool Plant. It is intended for the production and assembly of certain groups of control mechanisms that regulate the nuclear reactor's output, and also for the production of gears in heavy machine tools that are the principal products of this plant.

To raise the level of production management, to boost labor productivity and to save unskilled labor, the production system employs a computer to manage production and the handling of materials and tools. The purpose of the mentioned management system is to process planning, organizational and technical information, and to set up the production of the mentioned groups of products and parts, in such a way that the physical flow of materials and production aids may be controlled directly by means of this information, from the time that the materials and production aids enter the system, through production and assembly, until they leave the system.

The entire production system comprises four production departments, a material storehouse and initial processing shop, a tool department, a material transport system, and a control center.

Material Storehouse and Initial Processing Shop

The material storehouse and initial processing shop procure, maintain records on, and store all the materials necessary for the production departments. In the initial processing shop the arriving precut material is transferred onto transport pallets measuring 600 x 800 or 800 x 1200 mm, as individual transport batches.

The palletized material is stored in the pallet-rack storehouse that consists of three rows of simple racks, four rows of double racks, a stacker crane, and the stacker crane's transfer table. The capacity of the storehouse is about 1450 cells, and each cell can accomodate either one 800 x x 1200 mm pallet or two 600 x 800 mm pallets.

All storehouse records, the storing of incoming material, inventory control, and the readying of outgoing material to production are controlled by computer, through a terminal located in the storehouse. The transport pallet containing a transport batch of material is received at the storehouse acquisition point. From this point, information is transmitted automatically to the computer, requesting that the pallet be removed and stored. The computer sends the stacker crane to the acquisition point. The stacker crane loads the pallet, reads the pallet number from the coded label and sends it to the computer. The computer finds an empty rack cell and directs the stacker crane with the pallet to it. The computer stores in its memory the pallet number with the assigned address of the cell in which the pallet is stored. The other data regarding the transport batch on the given pallet, such as the serial number, order number, dimensions and type of material, number of pieces, etc., are entered in the computer through the terminal.

Tool Department

The tool department is designed as an integrated unit that includes a tool storeroom, a toolroom, and a tool-grinding shop.

In a departure from past practice, the workmen no longer pick up their tools at a tool-issuing room. Instead, a special pallet with tools and gages is transported with the material to the work station, for each operation. No distinction is made here between N/C and conventional work stations. The pallet with the tools is transported automatically from the toolroom to the work station and back. This pallet, too, is equipped with a coded label. The toolroom is linked with the control computer through its own terminal.

Handling of Materials and Tools Between Operations

The handling of materials and tools between operations is based on a system that includes the storehouse stacker crane with its transfer table. This stacker cran links up with the transverse stacker crane that interconnects the individual production departments and the material storehouse. Furthermore, the system has four stacker cranes that travel longitudinally along the axes of the individual production departments. The stacker cranes are supplemented by passive and active auxiliary equipment that jointly permit the automatic transport of materials and tools throughout the entire production system. This transport system is further supplemented by manually controlled equipment that enables direct handling of the workpieces at the work station, such as small rotary cranes, pneumatic balancers, air-cushion platforms, etc.

The stacker cranes are redesigned models 1339, made by Strojsmalt of Levoca. They have been modified mechanically and electrically, to meet the requirements of numerical control. The stacker cranes can be controlled either directly by the computer, by remote preselection of the address from the dispatcher's panel, or manually from the cab. Manual control is anticipated only as emergency control during debugging, repairs or the assembly of the stacker cranes.

The transfer table serves to transfer the storehouse stacker crane into the individual aisles between racks. It is designed for numerical control and may be controlled either directly by the computer, by remote preselection from the dispatcher's panel or, in emergencies, manually from the cab of the stacker crane that has rolled onto the transfer table.

The turning platforms permit the proper orientation of the pallets when they are transferred from the transverse stacker crane to a longitudinal stacker crane, and conversely. The runway of the transverse stacker crane and the runways of the production departments' stacker cranes are mutually perpendicular, and therefore the turning platforms rotate the transferred pallets 90°, always so that the pallet's coded label is properly oriented toward the code reader that is located on the stacker crane's lift.

The staging platforms ensure the transfer of pallets with products from the terminals of the longitudinal stacker cranes to the staging work station and back. At the staging work station a so-called assembly batch is made up of the individual items and is then sent to an assembly work station.

Racks are passive elements of the material- and tool-handling system. Three types of racks are used:

The five-level storehouse rack contains cells to store pallets, respectively to receive and issue them;

The tool rack is located in the front part of the tool department, along the transverse stacker crane. This is a two-level rack for the storage and transfer of the special pallets in which tools are transported;

The combined rack is located in the individual production departments. It is likewise a five-level rack and contains four types of cells for different special applications. On the first level are cells intended for the transfer of material to and from the individual work stations. On the second level are cells for the special tool pallets, and also permanently occupied cells equipped with lockers for the personal belongings of the crews at the individual work stations. On the other levels there are storage cells used to store the work in process between the individual operations, and to store finished parts before moving them to assembly. This rack also has tracks along which the underhung trolleys of the pneumatic balancers travel.

All the racks are of nonstandard design, built to meet the rigidity and precision requirements placed on them by the N/C stacker cranes.

The pneumatic balancers are of the pantograph type with a maximum load capacity of 180 kg, made by the Ostrov nad Ohri plant of the Skoda Departmental Enterprise. The underhung trolleys are nonstandard. The pneumatic balancers are used to manipulate the workpieces at the individual work stations. They merely balance the load; the load can be moved in any direction by the worker, with little effort.

The air-cushion platforms are used for the local handling of the material pallets at the work stations and in the initial processing shop. With their help it is easy to remove the pallets from the rack's first level and to position the pallets for the workers' convenience. The platforms are supported by four air-cushion cells 203 mm (8 inches) in diameter, made in America by the Aero-Go Company. The rated load capacity of the platform when the load is distributed evenly about its center is 950 kg. The platform is powered by compressed air from the shop's air line, reduced to a pressure of 90 kPa. The platforms move over a specially treated floor.

Three types of pallets are used in the system:

A standard metal box pallet 600 x 800 mm in size, with a load capacity of 500 kg. It is made by the Sfinx National Enterprise of Zleby. The pallet has been modified to arrest it while the stacker crane is in motion. It is also equipped with a holder for the coded label;

A standard metal box pallet 800 x 1200 mm in size, with a load capacity of 1000 kg (it is loaded to a maximum of 900 kg). The pallet is made by the same manufacturer and has the same modifications as mentioned above;

A special wooden pallet for transporting tools, 600 x 800 mm in size. The pallet is a wooden chest with four removable drawers, in which the individual tools are stored. The load capacity per drawer is 25 kg. This pallet, too, has been modified to arrest it while the stacker crane is in motion, and it is likewise equipped with a coded-label holder.

Chips are handled by a mechanized system consisting of conveyers installed under the shop floor and passing close to the individual machining work stations. The combined length of the conveyers is roughly 310 m. The conveyer system leads to an annex of the plat building where the chips are dumped into a total of 12 containers. Light signals on the signal pannels located in the production departments indicate what types of scrap are being transported at any given time. In this way the machine crews are informed about what chips they may discard onto the conveyers at the given moment. Transportation of the individual types of scrap alternates cylcically during a shift. This ensures the sorting of the scrap on the basis of its chemical composition. The entire conveyer system is controlled from a control panel located in a separate room.

Care is devoted also to draining off the cutting emulsions collected in waste troughs under the chip conveyers. In the troughs the cutting emulsions flow by gravity into a sump. From here the accumulated emulsions are pumped into a tankcar and transported to a waste-processing station, for disposal.

The machining work stations are located in the indivudal production departments, along the departmental racks. The total number of machining work stations is about 100, of which about 20 will be equipped with new N/C machines. The other work stations will have conventional machine tools.

A typical machining work station is equipped with three cells for materials (i.e., a capacity of three 800 x 1200 mm pallets or six 600 x 800 mm pallets), six cells for tool pallets, and a locker cell for the crew's personal belongings. Approximately two machining work stations share a pneumatic balancer, and an air-cushion platform.

The VS 43 Production System's Control System

The control system performs the functions of production scheduling, preparation, and the control of the production process, inspection and assembly.

There are four subsystems to perform these functions.

The technical preparation subsystem generates the basic design, technological and production information regarding all the produced parts. When a product is ordered for the first time, a "program for the control of the preparation and production process" (PRPVP) is prepared, and also a "technological process of parts" program. These basic documents contain the following:

The technological preparation of production, i.e., data for ordering materials and issuing production documents;

The actual production program (or process), i.e., the individual operations at the mechanized and manual work stations, inspection work stations, and the initial processing work stations.

The work stations and production aids necessary for the realization of the operations are assigned to the individual operations.

The data are organized into sets that are stored in a disk memory.

Production scheduling subsystem: Its input comprises the orders for gears and control mechanisms. These orders are processed in a group of tasks entitled "order monitoring." The output is a set of orders that contains the scheduling data of the orders, i.e., the desired delivery date, and the number of pieces.

"Control of the issuance of batches" is another group of tasks. Here, in the case of production for stock, the partial requirements are combined into established production batches, taking into consideration how far the work in process has advanced, and decisions are made concerning the issuance of new batches. In the case of the order method, a batch is issued on an order for the required number of pieces. The output of this processing is a set of issued batches.

The third group of tasks is the generation of a "production structure" set. This is compiled from the set of issued batches, and from the program for the control of the preparation and production process. The production-structure set contains all the data necessary for allocation and direct control.

Another group of tasks is "rough allocation." Here the capacities are reviewed by the individual groups of work stations, and the results are evaluated. The input comprises the production-structure items that represent production tasks, and the set of production resources (capacities) in a known breakdown of the capacities available during the given scheduling period. In this group of tasks, time limits are assigned to the individual production tasks so as to achieve best possible coordination between the capacity requirements and the available capacities. Fine allocation is achieved by assigning the production-structure items to sectors in a breakdown by individual work stations, in such a way that the planned time limits may be achieved, and all the work stations are loaded efficiently. This actually gives the daily schedules for the individual work stations. Another plan that fine allocation generates is the schedule for the preparation of production aids.

The requirements for readying all the finished parts, i.e., the work schedule of the staging work station, are met by a group of tasks entitled "schedule for the readying of parts."

The subsystem of direct control serves to control the flow of materials and production aids between work stations. It comprises the following:

Initial processing of materials,
Preparation of production aids,
Transport,
Ispection, and
Dispatcher control.

Materials enter the system in the initial processing shop. The shop's personnel requests an empty pallet, and transport presents it to the shop. Here the material is loaded into the pallet. The loaded pallet is sent back through the pallet-sequencing schedule. The initial processing shop communicates with the computer through its own computer terminal. Entry of the material into the system is recorded in the "production structure" set.

In the tool department, within the framework of the daily schedule broken down into so-called tool lists, the readied production aids are placed in the tool pallets. The tool department's foreman organized the work so that the daily schedule may be met. The pallets with the tools are assigned to the appropriate operations through a computer terminal located in the tool department. The pallets are removed into the system on a "take away" signal.

The "connecting program" evaluates the transport system's stations, namely the "take away" and "bring in" signals. The individual work stations' work loads are considered, and transport commands to present the appropriate pallet at the designated place are issued accordingly. The connecting program evaluates the results of fine allocation, and also the schedule for the readying of finished products.

The control of inspection ensures quality control of the incoming material, of the workpieces between operations, and of the finished parts and subassemblies. After each inspection, the number of rejects is reported to the "production structure" set, through the inspection work station's computer terminal.

When necessary, control inputs may be entered through the dispatcher's panel. This permits the solution of situation that were not envisaged in the schedule, and also of possible breakdowns in the system.

The data base subsystem contains the data, organized into sets, that are necessary for control. Access to the data and management of the sets are solved with the help of the "Datorg" system that is supplied with the Siemens S 330 computer, which controls the entire system.

From the described system we expect increased productivity, shorter production times for the produced parts, and fulfillment of the individual production items on schedule. The design concept of this system permits adaptation to both conventional and N/C work stations. The system may serve as a model for remodeling similar plants, in terms of the equipment and software used. All the workers of the Skoda Departmental Enterprise who are participating in the planning and realization of this project have gained extensive experience that certainly will be utilized in the elaboration of similar tasks.

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MACHINING CENTER FQH 50A IN ZPS GOTTWALDOV DESCRIBED

Prague STROJIRENSKA VYROBA in Czech No 6, Jun 79 pp 436-440

[Article by Engr Milos Hrdlicka, CSc, Precision Machine Plants National Enterprise, Gottwaldov]

[Text] The history of the FQH 50 machining center dates back to 1969. At that time the ZPS [Precision Machine Plants] Gottwaldov National Enterprise set the task of developing a functional model of the FQH 50 machining center that was to be the basic production unit in the proposed IVU 400 integrated production section. The task was fulfilled successfully in a very short time, and this machine was awarded a gold medal at the 1972 Brno International Engineering Fair. Based on the experience gained with the operation of this model, development of the prototype and production of the trial series were begun. The IVU 400 integrated production section, equipped with seven FQH 50 machining centers, was displayed already in 1973 at the Brno International Engineering Fair.

Trial operation of this many machines directly at the manufacturer made it possible to test the design within relatively short time, and also to master the technology of machining, and this contributed significantly toward shortening the time needed to assign the machine to series production.

ZPS Gottwaldov built fifty-two FQH 50 machines so far, and their timely commissioning at our engineering enterprises yields productivity gains for the users and simultaneously improves the working conditions.

Due to the constantly growing demand of our engineering industry, development of the FQH 50 machining center and of its accessories has not ceased. At present ZPS Gottwaldov is building the trial series of the FQH 50A, an improved type. The machine is being produced as model P3 (Fig. 1) for workpieces with nominal dimensions of up to 500x500x500 mm, and as model P 4 with a greater machining range, for workpieces with dimensions of up to 630x630x630 mm. The two models were developed by improving the P1 and P2 models of the FQH 50 machining center.

The machine has a horizontal spindle and a compound table. Basic motion in the perpendicular plane is provided by the spindle along the column guide in the Y axis; and in the horizontal plane, by the compound table, i.e., by the longitudinal table in the X axis, and the transverse table in the Z axis. The machine is equipped with an automatic magazine whose tools are prearranged and can be coded. Motion in all three axes X, Y, Z is generated with the help of frictionless lead screws and nuts; to reduce passive resistances, the guideways of the tables and head are equipped with pairs of preloaded bearing housings.

The most significant improvement in the machine is the application of Czechoslovak-made Mezomatic dc servodrives, made by MEZ [Moravian Electrical Appliance Plants] Brno, for the drives in the three coordinate axes. As a result, the regular- and quick-feed rates could be doubled. In the machine's hydraulic system, moreover, it was possible to eliminate the high-pressure section that supplied the hyraulic servomotors, required frequent and fairly demanding maintenance, and was a constant source of noise and heat. The ZH 180 hydraulic unit for the auxiliary functions (originally the hydraulic system's low-pressure section) is made by the specialized manufacturer TOS [Machine Tool Factories] Rakovnik, at its Vrchlabi plant.

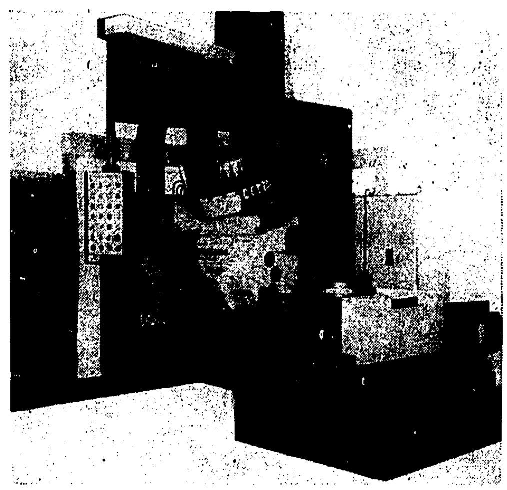


Figure 1. The FQH 50A model P3 machining center.

Other partial improvements of the machine include the more-rigid mounting of the spindle, tighter gripping of the tool holders in the spindle, a wider range of rpms, and the application of the experience gained with wet machining. Numerous requests by customers regarding the productivity of milling, particularly in the machining of metals, led to tightening the chuck's grip in the spindle. In conjunction with this, the spindle's front part was mounted more rigidly, specifically in the direction of the forces acting toward the spindle (Fig. 2). For the correspondig rigidity of the spindle itself, its front part was also reinforced.

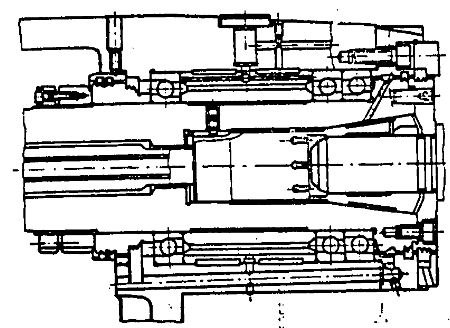


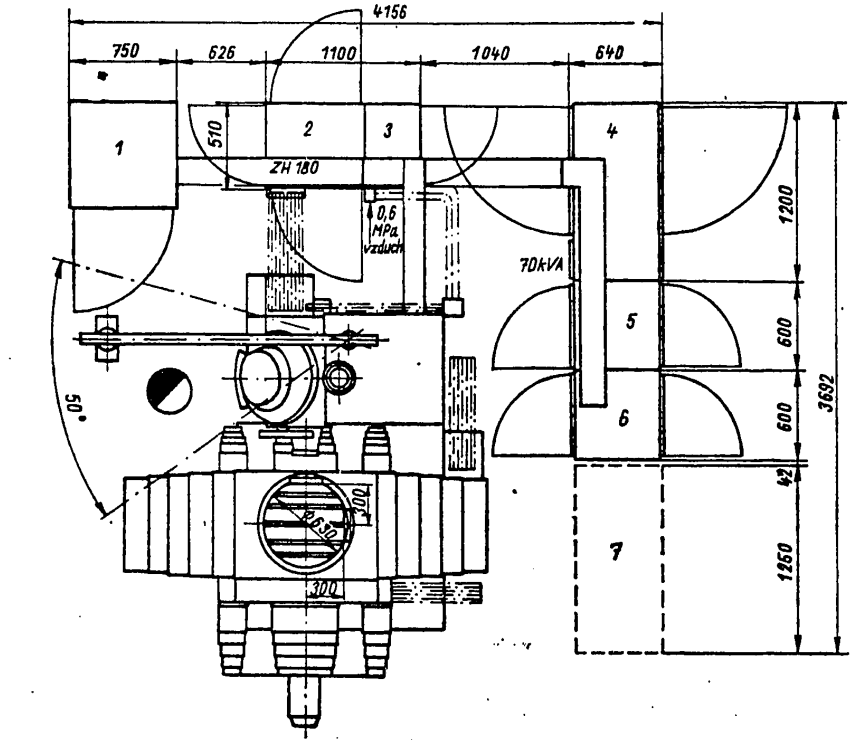
Figure 2. Mounting of spindle.

The spindle is driven by a 2SRT 160L variable-speed dc motor that has a built-in STZ 055e tachogenerator. The motor's rated output is 16 kW at 2800 rpm, through a two-speed transmission with electromagnetic claw coupling. The individual rpm speeds are switched by an analog signal according to a punched-tape program. The motor's reversing time is 0.5 sec. For the spindle's drive the MEZ Brno National Enterprise developed a new drive, the ?i RR5, designed on the basis of the Mezomatic servomotors' drive. The spindle's drive is housed in a separate cabinet outside the machine (Fig. 3).

The more-effective design of the spindle's temperature stabilization likewise serves to meet the increased requirements on machining. The spindle's temperature stabilization is achieved by setting the quantity of lubricating oil supplied to the spindle, and by controlling the oil temperature. The spindle-lubrication unit is housed in a separate cabinet whose sidewall is bolted to the hydraulic unit for auxiliary functions.

The machine is equipped with a circular automatic tool magazine for 30 prearranged tools, and with a mechanical arm for changigng the tools. The tool holders may be coded and then a reading device selects the tools.

The feed units of the FQH 50A machining center are designed on the same principle in all three axes X, Y, Z. The employed 50x10-diameter frictionless screw with a preloaded clasp nut is mounted on both sides on INA ZARN 4090 radial thrust bearings. The screw is connected to the actual servodrive by a torsionally rigid coupling that transfers toque but prevents radial and axial forces from loading the servomotor's shaft. The feed unit is equipped with a brake located on the opposite end of the frictionless screw.



Obr. 3. Půdorys uspořádání pracoviště obráběcího centra FQH 50A, provedení P4:
1 — řídicí systém NS 471; 2 — hydraulický agregát pomocných funkcí ZH 180; 3 — mazání vřeteníku; 4 — skříň přizpůsobovacích obvodů; 5 — skříň pohonu posuvů; 6 — skříň pohonu vřetena; 7 — chladicí zařízení nástrojů

Figure 3. Layout of work station for the FQH 50A Model P4 machining center: 1 - NS 471 control system; 2 - ZH 180 hydraulic unit for auxiliary functions; 3 - spindle lubrication; 4 - cabinet for adapting circuits; 5 - feed-drive cabinet; 6 - spindle-drive cabinet; 7 - equipment for wet machining.

The feeds are driven by Mezomatic P3 HR 444 electric drives made by MEZ Brno. The 3 SHAT 112M is a variable-speed dc motor with permanent-magnet excitation. The motor's rated torque is 47 Nm at 500 rpm. The R 3 TTI 444 triaxial reversing thyristor converter that controls the electric servomotors is housed in a separate cabinet outside the machine (Fig. 3).

The rotary table is designed as a separate unit that, after actual assembly, is accurately installed in the body of the longitudinal table. The table is positioned automatically according to a punched-tape program, in 5° steps, with an accuracy of division corresponding to ±3". The raising of the rotary table, which is necessary to turn it and to engage the spur gearing, is controlled hydraulically. The table's rotation is interlocked with the longitudinal table's movement in the X axis so that a 5-mm movement of the longitudinal table corresponds to a 5° turn of the rotary table. The rate of rotation depends on the rate of longitudinal feed.

Accurate positioning of the workpiece or fixture in the machine's system of coordinates is ensured by trip dogs that are parts of the rotary table.

The FQH 50A machining center normally uses the NS 471.02 numerical control system of the Tesla National Enterprise. However, the machine can be adapted also to other continuous-control systems that have the necessary auxiliary functions. Adaptations to the Philips N 6663, ECS 2101 and SAAB MTC 10 systems have been realized so far.

For measuring all three coordinates, the FQH 50A machining center equipped with the NS 471 control system uses a linear single-track inductosyn with a period of 2 mm, of precision grade A-5 μm. The measurement of each coordinate is formed by three scale divisions and a sliding contact. The extreme positions in the individual axes are secured by limit switches.

The machine's electrical equipment includes, in addition to the control system, also the cabinet of adapting and power circuits, and the actual electrical installation of the machine and of the hydraulic units. The cabinets are interconnected by a duct in which the cables and conductors connecting the cabinets to the machine are laid.

The controls for manual operation are located on a wall-hung control panel, and on a fixed panel on the spindle.

Special equipment supplied for the FQH 50A machine includes the following: PF 500 502, spare parts; PF 900 601, adjusting wedges for levelling the machine on its base; PF 900 901, coded-tool reader; PF 901 101, charger for the hydraulic accumulators; PF 900 403, tool-cooling system; PF 900 203-204, workpiece and machine shields for the P3 and P4 models in the case of wet machining; PF 901 002, spindle for machining light alloys; PF 900 102, basic set of tools; PF 901 401-403, chip extractors; PF 901 701, controls for multimachine operation.

Equipment is now being developed for palletization. This includes a semiautomatic pallet changer, and a rotary table with pallet changing.

In conjunction with the growing demands on the wet machining of steels with water-emulsion cutting fluids, close attention was devoted to this problem in the course of improving the machine. A cutting-fluid pump of larger capacity, 30 liters/min, was installed, and certain design modifications were made in shielding the machine and the workpiece, and in the location of the cutting-fluid jets. The machining methods and technological capabilities of the FHQ 50A machining center models P3 and P4 are essentially the same as for the FQH 50 machining center models P1 and P2, reported in greater detail in [1]. The mentioned publication describes the basic methods of machining, the machining of different types of materials, the suitability of the component base, the technological preparations for production,

Table 1. Principal Technical Characteristics

(1) Provedení		P3	P4
(2) Jmenovitý rozměr obrobku	[mm]	500×500×500	630×630×630
Upínací plocha otočného stolu (3)	[mm]	Ø 500	Ø 630
(4) Výška upínací plochy nad podlahou	[mm]	1100	1120
Pojezdy suportů v osách X, Y, Z (5)	[mm]	630×600×530	800×800×630
(6) Počet poloh otočného stolu		72	72
Přesnost dělení otočného stolu normální/zvýšená*) (7)		± 3″/± 1,5″	± 3″/± 1,5″
(8) Největší hmotnost obrobku včetně upínacího přípravku	[kg]	750	1000
(9) Počet stupňů otáček vřetena		87	87
Rozsah otáček (10)	(11) [l/min]	14–2000	14–2000
(12) Rozsah zvýšené řady otáček*)	[l/min]	14–3200	14–3200
(13) Stejnosměrný regulační motor vřetena – výkon	[kW]	16	16
– jmenovité otáčky (14)	[l/min]	2800	2800
(15) Rozsah plynule měnitelných posuvů v osách X, Y, Z	[mm/min]	10–2000	10–2000
Velikost rychloposuvů (16)	[mm/min]	10 000	10 000
(17) Moment stejnosměrného servomotoru posuvu	[Nm]	47	47
(18) Počet nástrojů v zásobníku	(19) [ks]	30	30
Čas automatické výměny nástroje (20)	[s] (21)	8	8
(22) Upínací stopka základního držáku nástroje	[mm]	Ø 44,45×95	Ø 44,45×95
Největší kužel komunálního nářadí (23)		ISO 40, MORSE 4	ISO 40, MORSE 4
(24) Pracovní tlak hydraulického agregátu ZH 180	[MPa]	6	6
Použitý olej OT - T3C, ČSN 65 6621 (25)	(26) [l]	100	100
(27) Přesnost najetí v souřadnicích X, Y, Z	[mm]	± 0,020	± 0,020
Opakovaná přesnost najetí (28)	[mm]	± 0,010	± 0,010
(29) Rozměry stroje (d×š×v)	[mm]	3147×2524×3122	3417×2524×3153
Hmotnost vlastního stroje (30)	[kg]	9000	9300
(31) Celková hmotnost včetně skříní a agregátů	[kg]	11 800	12 100
Doporučený rozměr pracoviště (32)	[mm]	6000×6000	6000×6000

(33) *) na zvláštní objednávku za příplatek

Key:

1. Model
2. Nominal dimensions of workpiece
3. Rotary table's working surface
4. Height of working surface from floor
5. Travel of supports in axes X, Y, Z
6. Number of rotary-table positions
7. Rotary table's division accuracy, regular/increased*
8. Maximum workpiece weight, including fixture
9. Number of spindle rpm steps
10. Range of rpms
11. Rpm
12. Increased range of rpms
13. Spindle's variable-speed dc motor - output
14. Rated rpm
15. Range of continuously variable feed rates in axes X, Y, Z
16. Quick-feed rate
17. Torque of feed's dc servomotor
18. Number of tools in magazine
19. Number
20. Duration of automatic tool change
21. Seconds

22. Shank of basic tool holder
23. Maximum taper of common tool
24. Operating pressure of the ZH 180 hydraulic unit
25. Oil used OT-T3C, Czechoslovak State Norm 65 6621
26. Liters
27. Positioning accuracy in axes X, Y, Z
28. Repeated positioning accuracy
29. Dimensions of machine (LxWxH)
30. Weight of machine proper
31. Overall weight, including cabinets and units
32. Recommended floor space of work station
33. *On special order, at additional cost

information on the tools and clamps used, the domestic and foreign customers' experience with the use of these machines, and list of the machines supplied to domestic and foreign customers.

The improved FQH 50A machine influences the technology primarily by its greater productivity, namely by the wider range of spindle rpms, by the doubling of the quick-feed rate to 10 m/min, and by the doubling of the maximum regular-feed rate to 2000 mm/min. This increase of the maximum regular-feed rate makes it possible to use faster feed rates in the X axis for the faster turning of the rotary table during positioning.

All the mentioned changes contribute primarily toward shortening the time of the machine's automatic operation, and thereby toward increasing its productivity. In addition to these effects of the described improvement, however, it is necessary to note also a series of secondary effects that include particularly the following:

Tighter gripping of the tool, and greater rigidity of the spindle and of its mounting;

More-efficient temperature stabilization of the spindle, with its impact on the machine's operating precision;

Easier and less-demanding maintenance in conjunction with the changeover to electric servodrives, and substantially more-simple lubrication;

Reduction of the noise level and, in combination with the more-simple lubrication, overall improvement of the working environment.

The customers' interest appears to be shifting at present toward the FQH 50A model P4 with its increased parameters. This follows primarily from the feasibility of machining larger workpieces on these machines. But it should be realized that the use of tools with longer reach, and possibly with longer travel, places the P4 model at a disadvantage in machining parts below the typical dimensions of 500x500x500 mm. Therefore the choice between models P3 and P4 should be based on a thorough analysis of the user's component base. This is one of the reasons why many manufacturers of machining centers offer series of machines graded according to maximum workpiece dimensions, so that each customer may choose a machine that corresponds to the nature of his component base.

BIBLIOGRAPHY

1. Lunga, J., and Blazek, J.: "Obrabeci centrum FQH 50" [The FQH 50 Machining Center], VUSTE [Engineering Technology and Economics Research Institute], Prague, 1978, pp 93. Supplement: "Third Stage of Task RPI-314-16, Efficient Application of NC Production Technology."

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